

**A COMPARATIVE EXPERIMENT IN  
SIMPLIFIED KEYBOARD RETRAINING AND  
STANDARD KEYBOARD SUPPLEMENTARY TRAINING**

A report of the retraining of ten Standard Keyboard typists on the Simplified Keyboard and a comparison with ten typists receiving identical instruction on the Standard Keyboard.



**Experiment Sponsored  
by  
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Directed and Reported

by

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## FOREWORD

With the processes of production, the distribution of goods, the activities of banks and public services continually increasing and expanding, sometimes at rates difficult to comprehend, efficiency in offices is essential to keep pace with this acceleration. To maintain this efficiency is to use to its best advantage the necessary tool for speeding up business communications--the typewriter.

The typewriter is the result of many years of experimentation. As early as 1800, several machines were produced in both the United States and England. But it was not until July 14, 1868, that the first practical typewriter was designed by Christopher Latham Sholes, Carlos Glidden, and S. W. Soule of Milwaukee, Wisconsin. In 1874, this typewriter was placed on the market.

Over the years, while mechanical improvements as well as convenient features were developed on the typewriter, the keyboard, known today as the Standard Keyboard, has remained essentially the same. While suggestions for changing the location of the keys on the keyboard have been made from time to time, it was not until 1936, however, that Dr. August Dvorak, Director of Research, University of Washington, Seattle, Washington, patented a keyboard known as the Simplified Keyboard. This keyboard is claimed to be scientifically arranged on the basis of the frequency of the use of letters and the frequency of letter patterns and sequences in the English language.

The development of the Simplified Keyboard has provoked discussion within the framework of the Federal Government concerning the relative merits of one keyboard over the other. Progress has been great in the clerical field in this country. Certainly no effort should be spared to improve what now exists. If the adoption of a new keyboard were found justifiable, a recommendation to that effect would be warranted. This, then, was the concern of the General Services Administration.

The problem of the Federal Government in adopting a new keyboard for the typewriter would be one of retraining of typists. This would be the same problem faced by business and industry. The Federal Government has no authority nor inclination to prescribe which keyboard should be used for the teaching of beginners in typewriting in the schools and colleges of this country. To recommend to the Federal Government the adoption of the Simplified Keyboard or any other keyboard (the Government has on file 15 different keyboards), which would require the retraining of thousands of typists, stenographers, and secretaries, it is logical that a substantial gain of speed and accuracy made by the typists on any different or new keyboard over those on the Standard Keyboard should be proved. Since the cost of retraining the typists, the cost of changing the keyboards on hand in government, and the production time lost during the period of retraining would amount to a sizeable sum, it is no small matter to make recommendations that involve 163,605 persons (as of August, 1954) using typing skill in working for the Federal Government.

In the main, information concerning the Simplified Keyboard has been based on findings issued by the patent holder. The research has involved either the training of persons from the beginning on the Simplified Keyboard or with the retraining of typists on the Simplified Keyboard. A comparative experiment, however, on the relative merits of both the Standard and the Simplified keyboards given under the same environmental conditions and involving the same instructional factors has never been made before the General Services Administration sponsored such an experiment as presented here.

This study, A Comparative Experiment in Simplified Keyboard Retraining and Standard Keyboard Supplementary Training, has created great interest since it began in January, 1956, as evidenced by its wide publicity in newspapers and periodicals throughout the country. The experiment has also caught the interest of several foreign countries.

The findings and conclusions presented in this report are made with due consideration given to the research that has been conducted in the past, including that of the patent holder of the Simplified Keyboard, and the impact of the findings on present and future typewriter users.

Recognition is given to the staff of the Personal Property Utilization Division of the Federal Supply Service for their interest, cooperation, and valuable assistance in providing the physical set-up for the conducting and completion of this research experiment. Recognition is given to Mrs. Adria Lynham, Director of the Washington School for Secretaries,

Washington, D. C., for her cooperation in releasing Mrs. Lorena Halterman Butterfield, Head of the Typewriting Department of that School, who was assigned to the project as the instructor. Appreciation is also given to those Federal agencies which made personnel available for the project. The participants themselves deserve a very large amount of credit.

## PART I

### BACKGROUND TO THE EXPERIMENT

A project was established by the Federal Supply Service, General Services Administration, in July, 1954, to study the possible advantages to the Federal Government of the Simplified Keyboard, patented by Dr. August Dvorak, over the Standard Keyboard. This project was created as the result of claims made by the proponents of the Simplified Keyboard, directed to members of Congress and the Executive Branch of the Government, that savings of many millions of dollars could be made through its adoption.

Information regarding the use of the Simplified Keyboard was sought from agencies of the Government and private industry which might have had experience with this keyboard. From this investigation, results of experiments performed by other agencies were obtained. From the Office of the Division Engineers, Great Lakes Division, Chicago, Illinois, the results of incomplete experiments made in 1946 were obtained; results of experiments performed under Dr. Dvorak's supervision in 1944 were obtained from the Navy Department; and from the Procurement Division of the Treasury Department the material covering the experiments performed in 1946, which were set up by Dr. Dvorak, was obtained.

In the course of the investigation made by the General Services Administration, information was obtained regarding a study proposed by the American Standards Association in 1952. Further investigation revealed

that the Association had a special committee appointed to study the entire subject headed by Dr. Earl P. Strong, of The Pennsylvania State University. Because of insufficient funds, this study was never started.

Dr. Strong was engaged in March, 1955, to direct a comparative experiment for the General Services Administration. In June, 1955, all of the material gathered by the General Services Administration was made available to Dr. Strong for his study and recommendations.

After reviewing the previous experiments performed on the Simplified Keyboard, it was apparent that no comparison had been made between typists operating the Standard Keyboard and those retrained to operate the Simplified Keyboard under comparable training and instruction. It was recommended, therefore, that a controlled, comparative experiment be made of ten typists using the Standard Keyboard as a control group, with ten typists retrained to use the Simplified Keyboard.

To assure unbiased instruction, it was recommended that an instructor be obtained who had no contact with any of the previous experiments. The Director of the Washington School for Secretaries agreed to cooperate by releasing a well-qualified staff member to instruct the participants in the experiment.

As funds were not readily available to hire personnel to participate in the experiment, which was estimated to run from three to four months, it was decided to enlist the aid of other Federal agencies in furnishing personnel to take part in the project. Accordingly, the agencies listed on the following page furnished the needed typists through detail for the duration of the project:



### Departments and Agencies Participating

|                             |                                 |
|-----------------------------|---------------------------------|
| Department of Agriculture   | Department of Labor             |
| Department of the Army      | Treasury Department             |
| Department of Commerce      | Department of the Navy          |
| Department of State         | Department of the Interior      |
| Department of the Air Force | Veterans Administration         |
| National Security Agency    | General Services Administration |

The Personnel Division of General Services Administration arranged with the U. S. Civil Service Commission to test and grade the typists from these agencies on the basis of education, training, aptitude, experience, mechanical skill, et cetera.

## PART II

### EXPERIMENTAL DESIGN

As originally planned, two groups were used in the experiment. One was the experimental group (referred to as Group A) and the control group (referred to as Group B). Group A typed on the Simplified Keyboard and Group B used the Standard Keyboard. Each group was set up to include ten participants. It is recognized that this constitutes a very small sample. Naturally, a sample of several hundred participants would have provided a much better basis for an interpretation of results. But in view of the repeated difficulties that were encountered in bringing together even this small group, it was believed better to proceed with the experiment with a small sample, realizing the limitations involved, than not to proceed at all.

In the original design of the experiment, each participant in Group B was to be "matched" with each participant in Group A. In other words, to match the two groups, ten persons would have had to be found whose factors corresponded to those found in the participants of Group A. This would have required the testing of hundreds of persons. Tests administered by the Civil Service Commission were to be used as the basis for such matching. This part of the design could not be carried out because of the too few persons upon whom to draw in order to match those in Group B with those selected for Group A through random sampling techniques. Under the circumstances, then, such a plan was impossible

and the idea of matching had to be abandoned. While it is regrettable from the standpoint of research that the two groups could not be matched, it is, nevertheless, believed that a great deal of valuable data has been obtained on the basis of the procedure that was finally followed.

#### Selection of Group A and Group B

To remove any chance for bias in the selection of the participants that were to be retrained on the Simplified Keyboard (Group A), the services of the Chief Statistician, Bureau of the Census, were utilized. The random selection of the members for Group A was made on the basis of classifying the twenty girls for the experiment into five groups with four persons in each group. Each group was homogeneous as far as possible with respect to test scores. From each homogeneous group of four, two persons were selected to use the Simplified Keyboard and two for the Standard Keyboard by using a random process which guaranteed that each person had an equal chance of being selected for the experimental group (Group A). At the same time, the process of selection equalized the number of persons who had experience on electric typewriters between the experimental (Group A) and the control (Group B) groups.

The participants that were selected by this random sampling process became the members of Group A. Those that remained after Group A had been selected by this process became members of Group B. While all typists volunteered for the program, no participant had a choice of whether she was to be retrained on the Simplified Keyboard or whether she was to receive supplementary training on the Standard Keyboard. While there were

some disappointments among participants in each group, all were good sports and cooperated fully in the experiment.

Based upon (1) the results of the tests given by the U. S. Civil Service Commission, and (2) random sampling methods using the Random Table of Numbers, the following groups were set up:

Numbers Assigned to the Experimental and Control Groups

| <u>Group A</u><br><u>Simplified Keyboard</u> |                  | <u>Group B</u><br><u>Standard Keyboard</u> |
|----------------------------------------------|------------------|--------------------------------------------|
|                                              | <u>Group I</u>   |                                            |
| No. 25                                       |                  | * No. 08                                   |
| * No. 09                                     |                  | No. 24                                     |
|                                              | <u>Group II</u>  |                                            |
| * No. 13                                     |                  | * No. 12                                   |
| No. 30                                       |                  | No. 07                                     |
|                                              | <u>Group III</u> |                                            |
| No. 27                                       |                  | No. 22                                     |
| No. 01                                       |                  | No. 05                                     |
|                                              | <u>Group IV</u>  |                                            |
| No. 29                                       |                  | No. 11                                     |
| No. 19                                       |                  | No. 15                                     |
|                                              | <u>Group V</u>   |                                            |
| * No. 14                                     |                  | * No. 20                                   |
| No. 28                                       |                  | No. 21                                     |

\*Denotes experience on electric typewriter.

NOTE: The numbers above, used in place of names, are those assigned by the U.S. Civil Service Commission at the time the battery of tests was given to the participants. They will be used throughout this report.

### Training Design

The ten participants in Group A were trained on the Simplified Keyboard until each member reached the speed she had typed on the Standard Keyboard prior to beginning her training on the Simplified Keyboard. The members of Group B were injected into the experiment after Group A had reached their original speeds on the Standard Keyboard.

Ideally, and as originally planned, these additions should have been made on an individual basis, for example, matching Mary with Susie, and Jane with Molly. In this experiment, however, the members of each group lost their individual identity, but each group remained intact as a group--Group A as such and Group B as such. The opportunity of comparing one individual with another who possessed similar characteristics was not possible in this case. Nevertheless, generalizations which are of value can be drawn from each group as a whole.

### U. S. Civil Service Commission Test Scores

The U. S. Civil Service Commission tested each participant not only to determine typing speed and accuracy but, in addition, manual dexterity, general intelligence, mechanical ability, et cetera. These factors were used as a basis for the random sampling selection of the Experimental Group (Group A).

PART III  
INSTRUCTION

The experimental design established two groups of ten typists each. Group A consisted of ten typists who retrained on the Simplified Keyboard typewriter; Group B consisted of ten typists who received supplementary training on the Standard Keyboard. Group A received instruction first and Group B was introduced at a later time. Since Group A typists were retrained to use the Simplified Keyboard, Group B typists were not brought into the classroom until such time as the speed on the Simplified Keyboard of the Group A typists paralleled their own speed on the Standard Keyboard.

Instructional Materials

For Simplified Keyboard typists: Simplified Keyboard Supplement for Scientific Typewriting, by Dvorak, Merrick, Ford, and Dealey.

For Standard and Simplified Keyboard typists: Scientific Typewriting - Standard Keyboard Edition, by Dvorak, Merrick, Ford, and Dealey.

Supplementary: Intensive drill material, including:  
Digraphs  
One-Hundred Typing Demons from Typing Behavior  
Speed Builders  
Accuracy Builders  
Selected-Goal Typing - One-Minute Timings  
Five-Minute Timed Writings - No. 1 through No. 8 taken from Speed Typing, by Tidwell and Bell.  
Kimball Contest Copy

### Teaching Schedule

The class period each day for five days a week consisted of four hours of instruction. Two hours of instruction each morning from ten o'clock until noon and two hours of instruction in the afternoon from one o'clock until three o'clock were given. Frequent breaks were allowed so that the participants did not become unduly tired. Short rest periods were given the typists between drills and practice in addition to the fifteen-minute rest break during the morning and afternoon sessions.

### Teaching Methods

The teaching methods followed are those generally advocated by recognized authorities on the teaching of typewriting. The general pattern of correct technique, speed, and accuracy with its attendant ultimate goal--control--was included in each day's instruction.

All drill was conducted as group activity with the participants typing from identical copy. During the practice periods, individual help was given when needed. Remedial and corrective drills were used individually as well as for group activity.

Because of the long class periods, intense drill and practice was alternated with brief relaxation periods. These periodic times of relaxation proved to be excellent breathers for the discussion of the improvement of techniques and for answering questions raised by participants. Every minute was utilized with the best interests of the participants in mind.

The use of one- and five-minute writings provided motivation for the two groups. Rates of speed and accuracy for each participant in each group were charted and posted daily so that each person could observe her progress in relation to others in the group. No distinction was made at any time between the type of instruction given or the attention shown the two groups. Both groups were conducted on a class basis with partiality for either group absolutely negative.

All variables were held as nearly constant as possible except, of necessity, the element of presenting the keyboard to Group A.

In retraining Group A on the Simplified Keyboard, the typists progressed at a steady pace. The alphabet was completed, including the hyphen key and all punctuation marks in five-and-a-half days of instruction and drill. This comprised Unit I. Ten days were spent on Unit II, which consisted of review, speed, and accuracy drill interspersed with drill for speed and control on word level drill, et cetera. Unit III included three days spent on practicing numerals and special characters; and Unit IV was started on February 28, 1956, on intensive drill on common words.

All timings were recorded on the basis of gross words a minute as well as the errors made on a given timed writing. For example, a person writing 56 words-a-minute with 4 errors on a five-minute writing would be given full credit for the rate at which she wrote--the gross rate. The record would be expressed as follows: 56 - 4 (5'). The reducing of speed and accuracy into a single composite score (net words a minute) was not used



in this experiment since such a formula distorts the facts and does not give a true index as to the real writing ability of the participant. By expressing all writings in terms of gross words a minute, a true index is given to the actual writing ability of the participant and in addition the accuracy of the particular writing as well as the length of time the writing took. Net words a minute ratings can be very misleading, while gross rates are more easily interpreted and can be accurately stated.

### Lesson Plans

Typical lesson plans for instruction on both the Simplified Keyboard and the Standard Keyboard are given on the following page. These are included so that the reader will know precisely the procedure that was followed daily. They are self-explanatory and hence no statement is included here concerning them. The amount of time devoted to each part in the daily procedure varied from time to time which gave variety to the daily procedure.

## A Typical Lesson Plan

### Simplified Keyboard

Textbook: Simplified Keyboard Supplement for Scientific Typewriting  
by Dvorak, Merrick, Ford, and Dealey

General Objectives: (a) To Fixate Control of Keyboard  
(b) To Modify Typewriting Behavior through Directed Practice

Specific Objectives: (a) To Rebuild the Finger-Pathway Reaches Learned in Lessons 1A and 2A  
(b) To Initiate Reach-Stroke to ?,pyfgcrl:  
(c) To Develop Manipulative Skill

#### Procedure:

- I. Warm-up - Conditioning Practice
  - (a) Finger Gymnastics
  - (b) Alternate Home Keys
- II. Recall Drill
  - (a) Reconstruct Reaches to Keys Previously Presented
  - (b) Rhythm Drill Page 10 for Quick Review
- III. Present Lesson 3A, Page 11
  - (a) Initiate New Controls
    - (1) Teacher Demonstration - New Locations
    - (2) Key Visualization Step
    - (3) Student Experimentation
  - (b) Intensive Unison Drill - Teacher Dictates, Setting Pace  
  
(Relaxation)
  - (c) Individual Drill - Teacher Observes  
  
(Fifteen-Minute Rest Period)
- IV. Practice Period
  - (a) Explanation of Rules and Spacing Applicable to Lesson
  - (b) Rhythm Drill - Balanced Keyboard Drill, Page 11
  - (c) Proofread Copy
  - (d) Practice Typing Demons  
  
(Relaxation)
- V. Timings
  - (a) One-half Minute Interval
  - (b) One-Minute Interval

(Lunch)

II. Direct Dictation - Unison Drill

III. Practice Period

(a) Continuous Copy, Page 12

(Fifteen-Minute Rest Period)

(b) Rhythmic Review, Page 12

(c) Proofread Copy

(Relaxation)

IV. Timings--Progress Check (GWAM)

(a) One-half Minute Interval

(b) One-Minute Interval

V. Remedial Practice

VI. Recall Drill

## A Typical Lesson Plan

### Control Group--Standard Keyboard

Textbook: Scientific Typewriting - Standard Keyboard Edition  
by Dvorak, Merrick, Ford, and Dealey

General Objective: To Measure Progress of Students Typing on Simplified  
Keyboard with Those Typing on the Standard Keyboard

Specific Objectives: (a) To Refine Techniques of Typing  
(b) To Develop Speed and Control with Continuity  
(c) To Build Skill in Typing Office Problems

#### Procedure:

##### I. Warm-up - Conditioning Practice

- (a) Experts' Rhythm Drill - asonetuhid a;sldkfjgh, etc.
- (b) 1 2 3 4 5 6 7 8 9 10
- (c) Warming-up Drill from Textbook

##### II. Practice Period

- (a) Balanced Keyboard Drills from Text
- (b) Article from Text
- (c) One-Hundred Typing Demons - Simplified and Standard Keyboard
- (d) Digraphs Based on 1000 Commonest Words

(Fifteen-Minute Rest Period)

##### III. Drill to Build Speed and Control - Develop Automatization

- (a) Word Level Drill
- (b) Phrase Level Drill
- (c) Timed Carriage Return Drill
- (d) Progressive Writings - Speed and Control Progression

(Relaxation)

##### IV. Timings - Progress Check (GWAM)

(Relaxation)

##### V. Remedial Practice

(One-Hour Lunch Period)

##### I. Manipulative Control Drill - To Improve Operative Technique

##### II. Drill to Build Speed and Control

- (a) Carriage Return Drill No. 2
- (b) Precision Writings
- (c) Guided Writing I

(Relaxation)

III. Timings - Progress Check (GWAM)

(Fifteen-Minute Rest Period)

IV. Practice Period

- (a) Instruction in Arrangement of Business Forms from  
Textbook
- (b) Preparation of Projects under Supervision

## PART IV

### FINDINGS

The findings of this experiment are grouped under the following headings: (1) time taken to retrain members of Group A to use the Simplified Keyboard; (2) differences in time taken to retrain highly skilled members of Group A compared with members having a relatively low skill; (3) gross speed attained by members of Group A as compared with members of Group B and accuracy (control) attained by members of Group A as compared with members of Group B; and (4) statistical analysis of the significance of the differences.

Throughout this report absolute figures are used rather than relative. Since the problem concerns itself with the improvement in gross speed and accuracy, absolute improvement is of greater importance than relative improvement.

Three of the participants in Group A and three in Group B had been using an electric typewriter prior to the experiment. One of these participants used an electric typewriter in the experiment. An examination of the results of the three participants in Group A and the three in Group B does not indicate that there was any handicap in their change-over to a manually-operated typewriter. Likewise, there is no indication that those who had been using a manually-operated typewriter was caused any inconvenience or was handicapped in any way by using an electric typewriter.

For the purposes of this experiment, the use or non-use of an electric typewriter was of no consequence.

Time Taken to Retrain Members of Group A to Use Simplified Keyboard

Table I shows the date, number of days (4 hours to each day) of instruction, and the number of instruction and drill hours required for each participant to get to her original speed on the Standard Keyboard before starting the experiment on January , 1956.

Table I shows further that, on the average, it took Group A a total of 25.2 days to regain their original speed on a 1-minute test, and 28.1 days to regain their original speed on a 5-minute test. In number of hours, it took Group A, on the average, 100.8 hours of instruction and drill to regain their original speed on a 1-minute test, and 112.4 hours on a 5-minute test. It should be noted that these times concern regaining only gross speed and not accuracy. Accuracy (control) on the Simplified Keyboard had not been regained to the original level at the time the experiment came to a close.

TABLE I

## SUMMARY FINDINGS ON SPEED FOR SIMPLIFIED KEYBOARD (GROUP A)

Number of Days and Hours of Instruction and Practice  
to Gain Back Original Speed

Starting January 31, 1956

| Participant's Number |          | Date | Number of Days<br>(Instructions) | Number of Hours<br>(Instructions) |
|----------------------|----------|------|----------------------------------|-----------------------------------|
| <u>Group I</u>       |          |      |                                  |                                   |
| No. 25               | 1-minute | 2/7  | 6                                | 24                                |
|                      | 5-minute | 2/10 | 9                                | 36                                |
| No. 09               | 1-minute | 2/14 | 11                               | 44                                |
|                      | 5-minute | 2/21 | 16                               | 64                                |
| <u>Group II</u>      |          |      |                                  |                                   |
| No. 13               | 1-minute | 3/8  | 26                               | 104                               |
|                      | 5-minute | 2/29 | 20                               | 80                                |
| No. 30               | 1-minute | 2/21 | 16                               | 64                                |
|                      | 5-minute | 2/28 | 20                               | 80                                |
| <u>Group III</u>     |          |      |                                  |                                   |
| No. 27               | 1-minute | 2/29 | 21                               | 84                                |
|                      | 5-minute | 4/23 | 58                               | 232                               |
| No. 01               | 1-minute | 4/18 | 52                               | 208                               |
|                      | 5-minute | 4/19 | 53                               | 212                               |
| <u>Group IV</u>      |          |      |                                  |                                   |
| No. 29               | 1-minute | 4/25 | 48                               | 192                               |
|                      | 5-minute | 4/19 | 45                               | 180                               |
| No. 19               | 1-minute | 2/23 | 15                               | 60                                |
|                      | 5-minute | 2/28 | 18                               | 72                                |
| <u>Group V</u>       |          |      |                                  |                                   |
| No. 14               | 1-minute | 3/23 | 38                               | 152                               |
|                      | 5-minute | 2/28 | 20                               | 80                                |
| No. 28               | 1-minute | 2/27 | 19                               | 76                                |
|                      | 5-minute | 3/1  | <u>22</u>                        | <u>88</u>                         |
| Average              | 1-minute |      | 25.2                             | 100.8                             |
|                      | 5-minute |      | 28.1                             | 112.4                             |



### Differences in Time Taken to Retrain Various Members of Group A

Great variation is noted in individual times taken to regain the original speed in both 1-minute and 5-minute writings. These variations are directly related to the degree of skill the participants had at the time they began the experiment. For example, No. 25 possessed the least skill in terms of typewriting gross speed of any of the other participants, yet the time to regain her original speed was accomplished in less time than any of the other participants, 24 hours on a 1-minute writing and 36 hours on a 5-minute writing. On the other hand, No. 01 possessed the highest skill in terms of typewriting gross speed of any of the other participants, yet it took her longer to regain her original speed than any of the other participants, 208 hours on a 1-minute writing and 212 hours on a 5-minute writing. This phenomenon can be explained by the fact that a person having a conscious level skill in typewriting can relearn a new keyboard more quickly than can a person who is on an automatized level, since the person who is automatized has many habit patterns to overcome that the conscious level typist does not have.

A study of the individual charts showing the day-to-day progress of each participant in both Groups A and B proved of value in noting differences in the progress of individuals in relation to their beginning skill. On each chart the beginning skill level was indicated for both 1-minute and 5-minute tests as well as the highest level attained during the training period. These two levels are used in the Tables that follow in this report.

### Gross Speed and Accuracy of Group A and Group B Compared.

Table II summarizes the beginning and ending gross speed rates and accuracy on 1-minute and 5-minute writings for each of the ten participants in Group A for the entire period of training. Since the experiment was designed to arrive at the improvement in skill in both gross speed and accuracy, the important column to study is the one showing the differences (improvements). Wide variation is apparent, depending a great deal upon the level of skill the participant had attained before beginning the retraining period. In any event, the average of the group on 1-minute writings shows a difference of 23.7 gross words a minute more than when the experiment was started; while the difference on 5-minute writings is 11.3 words a minute more than when the experiment started.

Accuracy (control) for the ten participants for the same period of training shows a 4.9 greater error rate for the 1-minute writings and a 7.9 greater error rate for the 5-minute writings. Such an increased error rate indicates that the participants as a whole did not have sufficient time to regain the control (accuracy) they had when they began the training period. Apparently, more time was needed to control the speed that was gained.

Table III summarizes the beginning and ending gross speed rates and accuracy on 1-minute and 5-minute writings for each of the ten participants in Group B for the period of training for this group, which started on March 5, 1956. It will be noted that there

TABLE II

SUMMARY FINDINGS ON SPEED AND ACCURACY  
FOR SIMPLIFIED KEYBOARD PARTICIPANTS

Starting on January 31, 1956

| Participant's Number |          | Gross Speed |           |           | Accuracy |           |          |
|----------------------|----------|-------------|-----------|-----------|----------|-----------|----------|
|                      |          | Begin.      | End       | Diff.     | Begin.   | End       | Diff.    |
| <u>Group I</u>       |          |             |           |           |          |           |          |
| No. 25               | 1-minute | 45          | 89        | 44        | 2        | 5         | 3        |
|                      | 5-minute | 36          | 60        | 24        | 5        | 11        | 6        |
| No. 09               | 1-minute | 76          | 114       | 38        | 4        | 7         | 3        |
|                      | 5-minute | 66          | 81        | 15        | 7        | 10        | 3        |
| <u>Group II</u>      |          |             |           |           |          |           |          |
| No. 13               | 1-minute | 78          | 90        | 12        | 0        | 13        | 13       |
|                      | 5-minute | 55          | 60        | 5         | 4        | 8         | 4        |
| No. 30               | 1-minute | 62          | 107       | 45        | 1        | 4         | 3        |
|                      | 5-minute | 50          | 71        | 21        | 3        | 13        | 10       |
| <u>Group III</u>     |          |             |           |           |          |           |          |
| No. 27               | 1-minute | 60          | 83        | 23        | 3        | 3         | 0        |
|                      | 5-minute | 52          | 54        | 2         | 5        | 8         | 3        |
| No. 01               | 1-minute | 94          | 99        | 5         | 2        | 14        | 12       |
|                      | 5-minute | 70          | 74        | 4         | 7        | 34        | 27       |
| <u>Group IV</u>      |          |             |           |           |          |           |          |
| No. 29               | 1-minute | 81          | 82        | 1         | 3        | 7         | 4        |
|                      | 5-minute | 52          | 55        | 3         | 6        | 14        | 8        |
| No. 19               | 1-minute | 83          | 112       | 29        | 0        | 7         | 7        |
|                      | 5-minute | 65          | 87        | 22        | 7        | 14        | 7        |
| <u>Group V</u>       |          |             |           |           |          |           |          |
| No. 14               | 1-minute | 74          | 84        | 10        | 2        | 2         | 0        |
|                      | 5-minute | 52          | 59        | 7         | 6        | 9         | 3        |
| No. 28               | 1-minute | 65          | 95        | 30        | 3        | 7         | 4        |
|                      | 5-minute | <u>51</u>   | <u>61</u> | <u>10</u> | <u>5</u> | <u>13</u> | <u>8</u> |
| Average              | 1-minute | 71.8        | 95.5      | 23.7      | 2.0      | 6.9       | 4.9      |
|                      | 5-minute | 54.9        | 66.2      | 11.3      | 5.5      | 13.4      | 7.9      |

TABLE III

SUMMARY FINDINGS ON SPEED AND ACCURACY  
FOR STANDARD KEYBOARD PARTICIPANTS

Starting on March 5, 1956

| Participant's Number |          | Gross Speed |           |           | Accuracy |          |           |
|----------------------|----------|-------------|-----------|-----------|----------|----------|-----------|
|                      |          | Begin.      | End       | Diff.     | Begin.   | End      | Diff.     |
| <u>Group I</u>       |          |             |           |           |          |          |           |
| No. 08               | 1-minute | 75          | 99        | 24        | 5        | 6        | 1         |
|                      | 5-minute | 46          | 68        | 22        | 8        | 4        | -4        |
| No. 24               | 1-minute | 69          | 91        | 22        | 2        | 0        | -2        |
|                      | 5-minute | 48          | 65        | 17        | 5        | 2        | -3        |
| <u>Group II</u>      |          |             |           |           |          |          |           |
| No. 12               | 1-minute | 85          | 120       | 35        | 0        | 2        | 2         |
|                      | 5-minute | 67          | 86        | 19        | 3        | 9        | 6         |
| No. 07               | 1-minute | 83          | 106       | 23        | 3        | 0        | -3        |
|                      | 5-minute | 60          | 77        | 17        | 6        | 9        | 3         |
| <u>Group III</u>     |          |             |           |           |          |          |           |
| No. 22               | 1-minute | 65          | 105       | 40        | 0        | 10       | 10        |
|                      | 5-minute | 53          | 87        | 34        | 8        | 16       | 8         |
| No. 05               | 1-minute | 75          | 90        | 15        | 4        | 4        | 0         |
|                      | 5-minute | 54          | 65        | 11        | 8        | 11       | 3         |
| <u>Group IV</u>      |          |             |           |           |          |          |           |
| No. 11               | 1-minute | 122         | 156       | 34        | 5        | 8        | 3         |
|                      | 5-minute | 90          | 114       | 24        | 22       | 16       | -6        |
| No. 15               | 1-minute | 88          | 117       | 29        | 0        | 7        | 7         |
|                      | 5-minute | 63          | 82        | 19        | 11       | 12       | 1         |
| <u>Group V</u>       |          |             |           |           |          |          |           |
| No. 20               | 1-minute | 85          | 129       | 44        | 0        | 1        | 1         |
|                      | 5-minute | 75          | 95        | 20        | 1        | 6        | 5         |
| No. 21               | 1-minute | 88          | 117       | 29        | 1        | 4        | 3         |
|                      | 5-minute | <u>61</u>   | <u>78</u> | <u>17</u> | <u>6</u> | <u>3</u> | <u>-3</u> |
| Average              | 1-minute | 83.5        | 113.0     | 29.5      | 2.0      | 4.2      | 2.2       |
|                      | 5-minute | 61.7        | 81.7      | 20.0      | 7.8      | 8.8      | 1.0       |

is not as much variation in the differences in Group B as compared with Group A. This is accounted for by the fact that this group did not have a new keyboard to learn but was improving their basic skill on the keyboard they had been trained upon. The average of the group on 1-minute writings shows a difference of 29.5 gross words a minute more than when the experiment started (5 weeks after Group A began its retraining on the Simplified Keyboard), while on 5-minute writings there is a difference of 20.0 gross words a minute more than when the experiment started.

Accuracy (control) for the same ten participants in Group B for the same period of training shows a 2.2 greater error rate for the 1-minute writing and a 1.0 greater error rate for the 5-minute writings. This greater error rate is somewhat lower than for those in Group A and it indicates that further control is necessary and can be attained through further drill and practice.

Table IV gives a summary of the speed and accuracy for both groups, showing a summary of the differences. It will be noted that Group B had a higher gross speed at the beginning of the experiment than did Group A on both 1-minute and 5-minute writings. Even though the participants in Group A had the greater opportunity to improve their speed, Group B participants improved 5.8 gross words a minute more than did those in Group A, and 8.7 gross words a minute more than did those in Group A. This is even more significant when it is noted that Group A participants had five weeks more skill training than did those in Group B.

The summary comparison of the accuracy of the two groups is extremely interesting. Group B participants made 2.3 more errors on 5-minute

TABLE IV  
COMPARISON OF SUMMARY FINDINGS FOR GROUP A AND GROUP B

Starting January 31, 1956

|                        | Gross Speed |       |       | Accuracy |      |       |
|------------------------|-------------|-------|-------|----------|------|-------|
|                        | Begin.      | End   | Diff. | Begin.   | End  | Diff. |
| Group A:               |             |       |       |          |      |       |
| 1-minute writings      | 71.8        | 95.5  | 23.7  | 2.0      | 7.0  | 5.0   |
| 5-minute writings      | 54.9        | 66.2  | 11.3  | 5.5      | 13.3 | 7.8   |
| Group B:               |             |       |       |          |      |       |
| 1-minute writings      | 83.5        | 113.0 | 29.5  | 2.0      | 4.2  | 2.2   |
| 5-minute writings      | 61.7        | 81.7  | 20.0  | 7.8      | 8.8  | 1.0   |
| Speed Differences:     |             |       |       |          |      |       |
| (Group B over Group A) |             |       |       |          |      |       |
| 1-minute writings      | 11.7        | 17.5  | 5.8   |          |      |       |
| 5-minute writings      | 6.8         | 15.5  | 8.7   |          |      |       |
| Accuracy Differences:  |             |       |       |          |      |       |
| (Group B over Group A) |             |       |       |          |      |       |
| 1-minute writings      |             |       |       | 0.0      | 2.8  | 2.8   |
| 5-minute writings      |             |       |       | 2.3      | 4.5  | 6.8   |

writings than those in Group A at the beginning of the experiment, and were exactly the same on 1-minute writings. At the end of the experiment, both groups made more errors. Group B participants, however, were 2.8 errors more accurate on 1-minute writings, and 6.8 errors more accurate on 5-minute writings.

Table V summarizes the beginning and ending gross speed rates and accuracy on 1-minute and 5-minute writings for each of the ten participants in Group A for the period from March 5, 1956, to the end of the experiment. Thus, a comparison is made of the gross speed and accuracy of each typist at the time those in Group A were injected into the classroom. Such a comparison will provide further evidence of the effects of the five-weeks' retraining period that Group A had in addition to those in Group B. The average improvement of Group A participants from March 5, 1956, to the end of the experiment on 1-minute writings was 22.8 gross words a minute, while the average improvement on 5-minute writings was 14.1 gross words a minute. Accuracy increased on 1-minute writings by 0.1 error, and decreased on 5-minute writings by 15.8 errors.

Table VI gives a comparison of the summary findings of Group A and Group B for the period March 5, 1956, to the end of the experiment. At the end of the five-weeks' retraining period and at the time Group B was added to the classroom group, it will be noted that those in Group B were faster on both 1-minute and 5-minute writings. In comparing the differences, Group B participants improved 6.7 gross words a minute more than did those in Group A, on 1-minute writings, and 5.9 gross words a minute

TABLE V  
SUMMARY FINDINGS ON SPEED AND ACCURACY  
FOR SIMPLIFIED KEYBOARD PARTICIPANTS

Starting March 5, 1956

| Participant's Number |          | Gross Speed |      |       | Accuracy  |      |       |
|----------------------|----------|-------------|------|-------|-----------|------|-------|
|                      |          | One Month   | End  | Diff. | One Month | End  | Diff. |
| <u>Group I</u>       |          |             |      |       |           |      |       |
| No. 25               | 1-minute | 65          | 89   | 24    | 4         | 5    | 1     |
|                      | 5-minute | 48          | 60   | 12    | 25        | 11   | -14   |
| No. 09               | 1-minute | 97          | 114  | 17    | 11        | 7    | - 4   |
|                      | 5-minute | 70          | 81   | 11    | 28        | 10   | -18   |
| <u>Group II</u>      |          |             |      |       |           |      |       |
| No. 13               | 1-minute | 72          | 90   | 18    | 4         | 13   | 9     |
|                      | 5-minute | 51          | 60   | 9     | 10        | 8    | - 2   |
| No. 30               | 1-minute | 73          | 107  | 34    | 0         | 4    | 4     |
|                      | 5-minute | 51          | 71   | 20    | 14        | 13   | - 1   |
| <u>Group III</u>     |          |             |      |       |           |      |       |
| No. 27               | 1-minute | 59          | 83   | 24    | 1         | 3    | 2     |
|                      | 5-minute | 44          | 54   | 10    | 11        | 8    | - 3   |
| No. 01               | 1-minute | 71          | 99   | 28    | 20        | 14   | - 6   |
|                      | 5-minute | 52          | 74   | 22    | 94        | 34   | -60   |
| <u>Group IV</u>      |          |             |      |       |           |      |       |
| No. 29               | 1-minute | 58          | 82   | 24    | 6         | 7    | 1     |
|                      | 5-minute | 41          | 55   | 14    | 28        | 14   | -14   |
| No. 19               | 1-minute | 98          | 112  | 14    | 5         | 7    | 2     |
|                      | 5-minute | 66          | 87   | 21    | 49        | 14   | -35   |
| <u>Group V</u>       |          |             |      |       |           |      |       |
| No. 14               | 1-minute | 67          | 84   | 17    | 5         | 2    | - 3   |
|                      | 5-minute | 50          | 59   | 9     | 16        | 9    | - 7   |
| No. 28               | 1-minute | 67          | 95   | 28    | 12        | 7    | - 5   |
|                      | 5-minute | 48          | 61   | 13    | 17        | 13   | - 4   |
| Average              | 1-minute | 72.7        | 95.5 | 22.8  | 6.8       | 6.9  | 0.1   |
|                      | 5-minute | 52.1        | 66.2 | 14.1  | 29.2      | 13.4 | -15.8 |



TABLE VI  
COMPARISON OF SUMMARY FINDINGS FOR GROUP A AND GROUP B

Starting March 5, 1956

|                                                 | <u>Gross Speed</u> |       |       | <u>Accuracy</u> |      |       |
|-------------------------------------------------|--------------------|-------|-------|-----------------|------|-------|
|                                                 | Begin.             | End   | Diff. | Begin.          | End  | Diff. |
| Group A:                                        |                    |       |       |                 |      |       |
| 1-minute writings                               | 72.7               | 95.5  | 22.8  | 6.8             | 6.9  | 0.1   |
| 5-minute writings                               | 52.1               | 66.2  | 14.1  | 29.2            | 13.4 | 15.8  |
| Group B:                                        |                    |       |       |                 |      |       |
| 1-minute writings                               | 83.5               | 113.0 | 29.5  | 2.0             | 4.2  | 2.2   |
| 5-minute writings                               | 61.7               | 81.7  | 20.0  | 7.8             | 8.8  | 1.0   |
| Speed Differences:<br>(Group B over Group A)    |                    |       |       |                 |      |       |
| 1-minute writings                               | 10.8               | 17.5  | 6.7   |                 |      |       |
| 5-minute writings                               | 9.6                | 15.5  | 5.9   |                 |      |       |
| Accuracy Differences:<br>(Group B over Group A) |                    |       |       |                 |      |       |
| 1-minute writings                               |                    |       |       | 4.8             | 2.7  | 2.1   |
| 5-minute writings                               |                    |       |       | 21.4            | 4.6  | 16.8  |

more than did those in Group A on 5-minute writings. It can be assumed, therefore, that the 5-weeks retraining period gave the participants in Group A no margin of advantage over those participants in Group B.

The summary comparison of the accuracy of the two groups indicates that while Group A participants made more errors on 1-minute writings, they made 2.1 fewer errors than did those in Group B; on 5-minute writings, while Group A participants made more errors than those in Group B, they showed more improvement than did those in Group B.

#### Statistical Analysis of the Significance of the Differences

Since this experiment dealt primarily in determining the improvement in both gross speed and accuracy (control) of typists using two different keyboard arrangements, it is important that the improvement shown by the beginning and ending rates of writing speed and the accuracy of that writing, which is shown by the differences, can be determined and whether or not they are significant.

In comparing gross speed improvement from the beginning of the experiment on January 31, 1956, to the end of the experiment, as summarized in Tables VII, VIII, IX, and X, it was found that for 1-minute writings there was no significant difference between the means, while for 5-minute writings there was a significant difference between the means, indicating that the Standard Keyboard was better. In comparing accuracy (control) improvement from the beginning of the experiment on January 31, 1956, to the end of the experiment, it was found that for 1-minute writings there was no significant difference between the means, while for the 5-minute writings there was a significant difference between the means, indicating that the Simplified Keyboard was better.

TABLE VII  
CHANGE IN GROSS SPEED--1 MINUTE WRITINGS

Starting January 31, 1956

|                    | Standard Keyboard                | Simplified Keyboard |              |
|--------------------|----------------------------------|---------------------|--------------|
|                    | 24                               | 44                  |              |
|                    | 22                               | 38                  |              |
|                    | 35                               | 12                  |              |
|                    | 23                               | 45                  |              |
|                    | 40                               | 23                  |              |
|                    | 15                               | 5                   |              |
|                    | 34                               | 1                   |              |
|                    | 29                               | 29                  |              |
|                    | 44                               | 10                  |              |
|                    | <u>29</u>                        | <u>30</u>           | <u>Total</u> |
| N                  | 10                               | 10                  | 20           |
| $\Sigma x$         | 295                              | 237                 | 532          |
| $\bar{x}$          | 29.5                             | 23.7                | 26.6         |
| $\Sigma x^2$       | 9413                             | 7945                | 17358        |
| $\bar{x} \Sigma x$ | 8702.5                           | 5616.9              | 14151.2      |
| $\Sigma x^2$       | 710.5                            | 2328.1              | 3206.8       |
|                    | <u><math>\Sigma x^2</math></u>   | <u>n</u>            | <u>y</u>     |
| Total              | 3206.8                           | 19                  |              |
| Within             | 3038.6                           | 18                  | 168.81       |
| Between            | 168.2                            | 1                   | 168.2        |
|                    | <u>168.2</u>                     |                     |              |
|                    | $F = \frac{168.2}{168.81} = .99$ |                     |              |

Conclusion: There is definitely no significant difference between the means.

TABLE VIII  
CHANGE IN GROSS SPEED--5-MINUTE WRITINGS

Starting January 31, 1956

|                   | Standard Keyboard              | Simplified Keyboard |              |
|-------------------|--------------------------------|---------------------|--------------|
|                   | 22                             | 24                  |              |
|                   | 17                             | 15                  |              |
|                   | 19                             | 5                   |              |
|                   | 17                             | 21                  |              |
|                   | 34                             | 2                   |              |
|                   | 11                             | 4                   |              |
|                   | 24                             | 3                   |              |
|                   | 19                             | 22                  |              |
|                   | 20                             | 7                   |              |
|                   | <u>17</u>                      | <u>10</u>           | <u>Total</u> |
| N                 | 10                             | 10                  | 20           |
| $\Sigma X$        | 200                            | 113                 | 313          |
| $\bar{X}$         | 20.0                           | 11.3                | 15.65        |
| $\Sigma X^2$      | 4326                           | 1929                | 6255         |
| $\bar{X}\Sigma X$ | 4000                           | 1276.9              | 4898.45      |
| $\Sigma x^2$      | 326                            | 652.1               | 1356.55      |
|                   | <u><math>\Sigma x^2</math></u> | <u>n</u>            | <u>V</u>     |
| Total             | 1356.55                        | 19                  |              |
| Within            | 978.1                          | 18                  | 54.34        |
| Between           | 378.45                         | 1                   | 378.48       |

$$F = \frac{378.48}{54.34} = 6.97$$

Conclusion: Better than 95 per cent sure that the difference between the means is not due to chance factors alone.

TABLE IX  
CHANGE IN ACCURACY--1-MINUTE WRITINGS  
Starting January 31, 1956

|                   | Standard Keyboard              | Simplified Keyboard |              |
|-------------------|--------------------------------|---------------------|--------------|
|                   | 1                              | 3                   |              |
|                   | -2                             | 3                   |              |
|                   | 2                              | 13                  |              |
|                   | -3                             | 3                   |              |
|                   | 10                             | 0                   |              |
|                   | 0                              | 12                  |              |
|                   | 3                              | 4                   |              |
|                   | 7                              | 7                   |              |
|                   | 1                              | 0                   |              |
|                   | <u>3</u>                       | <u>4</u>            | <u>Total</u> |
| N                 | 10                             | 10                  | 20           |
| $\Sigma X$        | 22                             | 49                  | 71           |
| $\bar{X}$         | 2.2                            | 4.9                 | 3.55         |
| $\Sigma X^2$      | 186                            | 421                 | 607          |
| $\bar{X}\Sigma X$ | 48.4                           | 240.1               | 252.05       |
| $\Sigma x^2$      | 137.6                          | 1809                | 354.95       |
|                   | <u><math>\Sigma x^2</math></u> | <u>n</u>            | <u>v</u>     |
| Total             | 354.95                         | 19                  |              |
| Within            | 318.5                          | 18                  | 17.69        |
| Between           | 36.45                          | 1                   | 36.45        |

$$F = \frac{36.45}{17.69} = 2.06$$

Conclusion: There is not a significant difference between the means.  
(F would have to be 4.41 or greater to be 95 per cent  
sure of a significant difference.)

TABLE X  
CHANGE IN ACCURACY--5-MINUTE WRITINGS

Starting January 31, 1956

|                    | Standard Keyboard              | Simplified Keyboard |              |
|--------------------|--------------------------------|---------------------|--------------|
|                    | -4                             | 6                   |              |
|                    | -3                             | 3                   |              |
|                    | 6                              | 4                   |              |
|                    | 3                              | 10                  |              |
|                    | 8                              | 3                   |              |
|                    | 3                              | 27                  |              |
|                    | -6                             | 8                   |              |
|                    | 1                              | 7                   |              |
|                    | 5                              | 3                   |              |
|                    | <u>-3</u>                      | <u>8</u>            | <u>Total</u> |
| N                  | 10                             | 10                  | 20           |
| $\Sigma X$         | 10                             | 79                  | 89           |
| $\bar{X}$          | 1.0                            | 7.9                 | 4.45         |
| $\Sigma X^2$       | 214                            | 1085                | 1299         |
| $\bar{X} \Sigma x$ | 10                             | 624.1               | 396.05       |
| $\Sigma x^2$       | 204                            | 460.9               | 902.95       |
|                    | <u><math>\Sigma x^2</math></u> | <u>n</u>            | <u>V</u>     |
| Total              | 902.95                         | 19                  |              |
| Within             | 664.9                          | 18                  | 36.94        |
| Between            | 238.05                         | 1                   | 238.05       |

$$F = \frac{238.05}{36.94} = 6.44$$

Conclusion: The difference between the means is significant. It is 97 per cent sure that this difference is not due to chance factors alone.

In comparing gross speed improvement from March 5, 1956, to the end of the experiment, as summarized in Tables XI, XII, XIII, XIV, XV, XVI, and XVII, it was found that for 1-minute writings there was no significant difference between the means, while for the 5-minute writings there was a significant difference between the means indicating that the Standard Keyboard was better (this was true whether the three exceptional cases were omitted or included). In comparing accuracy (control) improvement from March 5, 1956, to the end of the experiment, it was found that for 1-minute writings there was no significant difference between the means, while for the 5-minute writings there was a significant difference between the means indicating that the Standard Keyboard was better.

TABLE XI  
CHANGE IN GROSS SPEED--1-MINUTE WRITINGS

Starting March 5, 1956

|                   | Standard Keyboard              | Simplified Keyboard |              |
|-------------------|--------------------------------|---------------------|--------------|
|                   | 24                             | 24                  |              |
|                   | 22                             | 17                  |              |
|                   | 35                             | 18                  |              |
|                   | 23                             | 34                  |              |
|                   | 40                             | 24                  |              |
|                   | 15                             | 28                  |              |
|                   | 34                             | 24                  |              |
|                   | 29                             | 14                  |              |
|                   | 44                             | 17                  |              |
|                   | <u>29</u>                      | <u>28</u>           | <u>Total</u> |
| N                 | 10                             | 10                  | 20           |
| $\Sigma X$        | 295                            | 228                 | 523          |
| $\bar{X}$         | 29.5                           | 22.8                | 26.15        |
| $\Sigma X^2$      | 9413                           | 5550                | 14963        |
| $\bar{X}\Sigma X$ | 8702.5                         | 5198.4              | 13676.45     |
| $\Sigma x^2$      | 710.5                          | 351.6               | 1286.55      |
|                   | <u><math>\Sigma x^2</math></u> | <u>n</u>            | <u>V</u>     |
| Total             | 1286.55                        | 19                  |              |
| Within            | 1062.1                         | 18                  | 59.01        |
| Between           | 224.45                         | 1                   | 224.45       |

$$F = \frac{224.45}{59.01} = 3.80$$

Conclusion: The difference between the means is not significant, but it is close. (If  $F = 4.41$ , there would be a 95 per cent certainty of a significant difference.)

NOTE: By omitting Nos. 01, 29, and 14, the mean would equal 22.71 instead of 22.8, which would not be a sufficient difference to change the conclusion.



TABLE XII  
CHANGE IN GROSS SPEED--5-MINUTE WRITINGS

Starting March 5, 1956

|                   | Standard Keyboard              | Simplified Keyboard |              |
|-------------------|--------------------------------|---------------------|--------------|
|                   | 22                             | 12                  |              |
|                   | 17                             | 11                  |              |
|                   | 19                             | 9                   |              |
|                   | 17                             | 20                  |              |
|                   | 34                             | 10                  |              |
|                   | 11                             | 22                  |              |
|                   | 24                             | 14                  |              |
|                   | 19                             | 21                  |              |
|                   | 20                             | 9                   |              |
|                   | <u>17</u>                      | <u>13</u>           | <u>Total</u> |
| N                 | 10                             | 10                  | 20           |
| $\Sigma X$        | 200                            | 141                 | 341          |
| $\bar{X}$         | 20.0                           | 14.1                | 17.05        |
| $\Sigma X^2$      | 4326                           | 2217                | 6543         |
| $\bar{X}\Sigma X$ | 4000                           | 1988.1              | 5814.05      |
| $\Sigma x^2$      | 326                            | 228.9               | 728.95       |
|                   | <u><math>\Sigma x^2</math></u> | <u>n</u>            | <u>V</u>     |
| Total             | 728.95                         | 19                  |              |
| Within            | 554.9                          | 18                  | 30.83        |
| Between           | 174.05                         | 1                   | 174.05       |

$$F = \frac{174.05}{30.83} = 5.65$$

Conclusion: The difference between the means is significant. It is 95 per cent sure that this difference is not due to chance factors alone.

TABLE XIII

## CHANGE IN GROSS SPEED--5-MINUTE WRITINGS

Starting March 5, 1956

(Omitting Nos. 27, 01, and 29)

|                                   | Standard Keyboard              | Simplified Keyboard |              |
|-----------------------------------|--------------------------------|---------------------|--------------|
|                                   | 22                             | 12                  |              |
|                                   | 17                             | 11                  |              |
|                                   | 19                             | 9                   |              |
|                                   | 17                             | 20                  |              |
|                                   | 34                             | 21                  |              |
|                                   | 11                             | 9                   |              |
|                                   | 24                             | 13                  |              |
|                                   | 19                             |                     |              |
|                                   | 20                             |                     |              |
|                                   | <u>17</u>                      | —                   | <u>Total</u> |
| N                                 | 10                             | 7                   | 17           |
| $\Sigma X$                        | 200                            | 95                  | 295          |
| $\bar{X}$                         | 20                             | 13.57               | 17.35        |
| $\Sigma X^2$                      | 4326                           | 1437                | 5763         |
| $\bar{X} \Sigma X$                | 4000                           | 1289.15             | 5118.25      |
| $\Sigma X^2$                      | 326                            | 147.85              | 644.75       |
|                                   | <u><math>\Sigma X^2</math></u> | <u>n</u>            | <u>V</u>     |
| Total                             | 644.75                         | 16                  |              |
| Within                            | 473.85                         | 15                  | 31.59        |
| Between                           | 170.90                         | 1                   | 170.90       |
| $F = \frac{170.90}{31.59} = 5.41$ |                                |                     |              |

Conclusion: The same as with the three omitted items included.

TABLE XIV  
CHANGE IN ACCURACY--1-MINUTE WRITINGS

Starting March 5, 1956

|                    | Standard Keyboard              | Simplified Keyboard |              |
|--------------------|--------------------------------|---------------------|--------------|
|                    | 1                              | 1                   |              |
|                    | -2                             | -4                  |              |
|                    | 2                              | 9                   |              |
|                    | -3                             | 4                   |              |
|                    | 10                             | 2                   |              |
|                    | 0                              | -6                  |              |
|                    | 3                              | 1                   |              |
|                    | 7                              | 2                   |              |
|                    | 1                              | -3                  |              |
|                    | <u>3</u>                       | <u>-5</u>           | <u>Total</u> |
| N                  | 10                             | 10                  | 20           |
| $\Sigma X$         | 22                             | 1                   | 23           |
| $\bar{X}$          | 2.2                            | 0.1                 | 1.15         |
| $\Sigma X^2$       | 186                            | 193                 | 379          |
| $\bar{X} \Sigma X$ | 48.4                           | .1                  | 26.45        |
| $\Sigma x^2$       | 137.6                          | 192.9               | 352.55       |
|                    | <u><math>\Sigma x^2</math></u> | <u>n</u>            | <u>V</u>     |
| Total              | 352.55                         | 19                  |              |
| Within             | 330.5                          | 18                  | 18.36        |
| Between            | 22.05                          | 1                   | 22.05        |

$$F = \frac{22.05}{18.36} = 1.20$$

Conclusion: The difference between the means is nowhere close to being significant.

TABLE XV  
CHANGE IN ACCURACY--1-MINUTE WRITINGS

Starting March 5, 1956  
(Omitting No. 01 and No. 29)

|                    | Standard Keyboard              | Simplified Keyboard |              |
|--------------------|--------------------------------|---------------------|--------------|
|                    | 1                              | 1                   |              |
|                    | -2                             | -4                  |              |
|                    | 2                              | 9                   |              |
|                    | -3                             | 4                   |              |
|                    | 10                             | 2                   |              |
|                    | 0                              | 2                   |              |
|                    | 3                              | -3                  |              |
|                    | 7                              | -5                  |              |
|                    | 1                              |                     |              |
|                    | <u>3</u>                       | <u>—</u>            | <u>Total</u> |
| N                  | 10                             | 8                   | 18           |
| $\Sigma X$         | 22                             | 6                   | 28           |
| $\bar{X}$          | 2.2                            | 0.75                | 1.5556       |
| $\Sigma X^2$       | 186                            | 156                 | 342          |
| $\bar{X} \Sigma X$ | 48.4                           | 4.5                 | 43.56        |
| $\Sigma x^2$       | 137.6                          | 151.5               | 298.44       |
|                    | <u><math>\Sigma x^2</math></u> | <u>n</u>            | <u>V</u>     |
| Total              | 298.44                         | 17                  |              |
| Within             | 289.1                          | 16                  | 18.07        |
| Among              | 9.34                           | 1                   | 9.34         |

$$F = \frac{9.34}{18.07} = .52$$

Conclusion: There is definitely no significant difference between the means.

TABLE XVI

## CHANGE IN ACCURACY--5-MINUTE WRITINGS

Starting March 5, 1956  
(Using all items)

|                   | Standard Keyboard              | Simplified Keyboard |              |
|-------------------|--------------------------------|---------------------|--------------|
|                   | -4                             | -14                 |              |
|                   | -3                             | -18                 |              |
|                   | 6                              | - 2                 |              |
|                   | 3                              | - 1                 |              |
|                   | 8                              | - 3                 |              |
|                   | 3                              | -60                 |              |
|                   | -6                             | -14                 |              |
|                   | 1                              | -35                 |              |
|                   | 5                              | - 7                 |              |
|                   | <u>-3</u>                      | <u>- 4</u>          | <u>Total</u> |
| N                 | 10                             | 10                  | 20           |
| $\Sigma X$        | 10                             | -158                | -148         |
| $\bar{X}$         | 1.0                            | - 15.8              | - 7.4        |
| $\Sigma X^2$      | 214                            | 5620                | 5834         |
| $\bar{X}\Sigma X$ | 10                             | 2496.4              | 1095.2       |
| $\Sigma x^2$      | 204                            | 3123.6              | 4738.8       |
|                   | <u><math>\Sigma x^2</math></u> | <u>n</u>            | <u>V</u>     |
| Total             | 4738.8                         | 19                  |              |
| Within            | 3327.6                         | 18                  | 184.87       |
| Between           | 1411.2                         | 1                   | 1411.2       |

$$F = \frac{1411.2}{184.87} = 7.63$$

Conclusion: The difference between the means is significant. It is 98 per cent sure that the difference is not due to chance factors alone.

TABLE XVII

## CHANGE IN ACCURACY--5-MINUTE WRITINGS

Starting March 5, 1956  
(Omitting Nos. 27, 01, and 29)

|                   | Standard Keyboard              | Simplified Keyboard |              |
|-------------------|--------------------------------|---------------------|--------------|
|                   | -4                             | -14                 |              |
|                   | -3                             | -18                 |              |
|                   | 6                              | - 2                 |              |
|                   | 3                              | - 1                 |              |
|                   | 8                              | -35                 |              |
|                   | 3                              | - 7                 |              |
|                   | -6                             | - 4                 |              |
|                   | 1                              |                     |              |
|                   | 5                              |                     |              |
|                   | <u>-3</u>                      | <u>      </u>       | <u>Total</u> |
| N                 | 10                             | 7                   | 17           |
| $\Sigma X$        | 10                             | -81                 | -71          |
| $\bar{X}$         | 1.0                            | -11.571             | - 4.176      |
| $\Sigma X^2$      | 214                            | 1815                | 2029         |
| $\bar{X}\Sigma X$ | 10                             | 937.25              | 296.50       |
| $\Sigma x^2$      | 204                            | 877.75              | 1732.50      |
|                   | <u><math>\Sigma x^2</math></u> | <u>n</u>            | <u>V</u>     |
| Total             | 1732.50                        | 16                  |              |
| Within            | 1081.75                        | 15                  | 72.12        |
| Between           | 650.75                         | 1                   | 650.75       |

$$F = \frac{650.75}{72.12} = 9.02$$

Conclusion: The difference between the means is significant. There is less than 1 per cent probability that this difference is due to chance factors.

PART V  
CONCLUSIONS

1. A minimum of 100 hours of instruction and drill time is required to retrain a typist on the Simplified Keyboard (allowing 4 hours a day for instruction and intensified drill and practice).
2. Simplified Keyboard typists showed less improvement in speed than did the Standard Keyboard typists on both 1-minute and 5-minute writings for the total period of the experiment.
3. Simplified Keyboard typists showed less control (accuracy) than did the Standard Keyboard typists on both 1-minute and 5-minute writings for the total period of the experiment.
4. Simplified Keyboard typists showed less improvement in speed than did the Standard Keyboard typists on both 1-minute and 5-minute writings for the period from March 5, 1956, to the end of the experiment.
5. Simplified Keyboard typists showed less control (accuracy) than did the Standard Keyboard typists on both 1-minute and 5-minute writings for the period from March 5, 1956, to the end of the experiment.
6. The results of the statistical analyses of the differences in improvement indicate that there are no significant differences on the 1-minute

writings for either speed or accuracy, but on 5-minute writings it was found that the Standard Keyboard results are better in both speed and accuracy and that the differences are significant, except for the accuracy on the 5-minute writing, starting January 31, 1956, which indicates the Simplified Keyboard was better.

7. A recommendation for the adoption of the Simplified Keyboard for use by the Federal Government cannot be justified based upon the findings of this experiment.

June 14, 1956